RADAR Titan Flyby during S27/T23

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- Sequence: s27
- Rev: 037
- Observation Id: t23
- Target Body: Titan
- Data Take Number: 111
- PDT Config File: S27_ssup_psiv1_061102_pdt.cfg
- SMT File: s27_smt_061020.rpt
- PEF File: z0270d.pef

1 Introduction

This memo describes the Cassini RADAR activities for the 12th Titan flyby on which SAR data will be acquired. This SAR data collection occurs during the s27 sequence of the Saturn Tour. This is a full radar pass except for one hour after the outbound scatterometer raster scan when UVIS takes control. The SAR profile is pushbroomed on both ends. A sequence design memo provides the science context of the scheduled observations, an overview of the pointing design, and guidlines for preparing the RADAR IEB.

2 CIMS and Division Summary

Each RADAR observation is represented to the project by a set of requests in the Cassini Information Management System (CIMS). The CIMS database contains requests for pointing control, time, and data volume. The CIMS requests show a high-level view of the sequence design. Table 1 shows the CIMS request summary for this observation. Although the CIMS requests show Low-SAR intervals, in reality the radar will be operated in Hi-SAR mode throughout this flyby.

The CIMS requests form the basis of a pointing design built using the project pointing design tool (PDT). The details of the pointing design are shown by the PDT plots on the corresponding tour sequence web page. (See https://cassini.jpl.nasa.gov/radar.) The RADAR pointing sequence is ultimately combined with pointing sequences from other instruments to make a large merged c-kernel. C-kernels are files containing spacecraft attitude data.

A RADAR tool called RADAR Mapping and Sequencing Software (RMSS) reads the merged c-kernel along with other navigation data files, and uses these data to produce a set of instructions for the RADAR observation. The RADAR instructions are called an Instrument Execution Block (IEB). The IEB is produced by running RMSS with a radar config file that controls the process of generating IEB instructions for different segments of time. These segments of time are called divisions with a particular behavior defined by a set of division keywords in the config file. Table 2

CIMS ID	Start	End	Duration	Comments
037TI_T23WARMUP001_RIDER	2007-013T00:35:43	2007-013T03:35:43	03:00:0.0	Warmup for inbound radiometry of Titan
037TI_T23INRAD001_PRIME	2007-013T03:35:43	2007-013T07:20:43	03:45:0.0	High latitude radiometry of unique terrain coverage of Titan inbound
037TI_T23INSCAT001_PRIME	2007-013T07:20:43	2007-013T07:43:43	00:23:0.0	High latitude scatterometry of Titan (complements T19)
037TI_T23INALT001_PRIME	2007-013T08:05:43	2007-013T08:20:43	00:15:0.0	Inbound altimetry of T23
037TI_T23INLSAR001_PRIME	2007-013T08:20:43	2007-013T08:28:43	00:08:0.0	Inbound low resolution SAR imaging on T23 flyby
037TI_T23HISAR001_PRIME	2007-013T08:28:43	2007-013T08:42:43	00:14:0.0	High resolution SAR imaging for 12 minutes around closest approach
037TI_T23OTLSAR001_PRIME	2007-013T08:42:43	2007-013T08:50:43	00:08:0.0	Outbound low resolution SAR imaging on T23 flyby
037TI_T23OUTALT001_PRIME	2007-013T08:50:43	2007-013T09:05:43	00:15:0.0	Outbound altimetry of T23
037TI_T23OTSCAT001_PRIME	2007-013T09:05:43	2007-013T09:39:43	00:34:0.0	High latitude scatterometry of Titan (complements T19)
037TI_T23OUTRAD001_PRIME	2007-013T10:16:43	2007-013T13:35:43	03:19:0.0	High latitude radiometry of unique terrain coverage of Titan outbound to complete truncated T21 observation

Table 1: t23 CIMS Request Sequence

Division	Name	Start	Duration	Data Vol	Comments
a	Warmup	-8:20:0.0	03:19:0.0	3.0	Warmup
b	standard_radiometer_inbound	-5:01:0.0	03:37:0.0	12.9	Inbound radiometry
c	standard_scatterometer_inbound	-1:24:0.0	00:11:0.0	19.8	Inbound scatterometer raster
d	standard_scatterometer_inbound	-1:13:0.0	00:20:48.0	37.4	Inbound scatterometer raster
e	standard_altimeter_inbound	-0:52:12.0	00:32:6.0	77.0	Inbound altimetry, reduced duty cycle
f	standard_altimeter_inbound	-0:20:6.0	00:00:2.0	0.4	altimetry test 8-8
g	standard_altimeter_inbound	-0:20:4.0	00:00:2.0	0.4	altimetry test 8-8, and reduced duty cycle
h	standard_altimeter_inbound	-0:20:2.0	00:00:2.0	0.4	altimetry test 8-8, reduced duty cycle and bandwidth
i	standard_sar_hi	-0:20:0.0	00:01:50.0	26.2	Hi-SAR Turn transition, beam 3 only
j	standard_sar_low_inbound	-0:18:10.0	00:00:12.0	2.6	Inbound Low-SAR ping-pong
k	standard_sar_hi	-0:17:58.0	00:00:12.0	2.9	Inbound Hi-SAR ping-pong
l	standard_sar_low_inbound	-0:17:46.0	00:00:12.0	2.6	Inbound Low-SAR ping-pong
m	standard_sar_hi	-0:17:34.0	00:00:12.0	2.9	Inbound Hi-SAR ping-pong
n	standard_sar_low_inbound	-0:17:22.0	00:00:12.0	2.6	Inbound Low-SAR ping-pong
o	standard_sar_hi	-0:17:10.0	00:00:12.0	2.9	Inbound Hi-SAR ping-pong
p	standard_sar_low_inbound	-0:16:58.0	00:00:12.0	2.6	Inbound Low-SAR ping-pong
q	standard_sar_hi	-0:16:46.0	00:00:12.0	2.9	Inbound Hi-SAR ping-pong
r	standard_sar_low_inbound	-0:16:34.0	00:00:34.0	7.3	Inbound Low-SAR ping-pong
s	standard_sar_hi	-0:16:0.0	00:32:0.0	457.0	Hi-SAR main swath
t	standard_sar_low_outbound	00:16:0.0	00:02:30.0	32.2	Outbound Low-SAR
u	standard_sar_hi	00:18:30.0	00:02:0.0	28.6	Hi-SAR turn transition to altimetry, B3 only
v	standard_altimeter_outbound	00:20:30.0	00:08:24.0	20.2	Outbound altimetry, reduced duty cycle
w	standard_altimeter_outbound	00:28:54.0	00:00:2.0	0.4	altimetry test 8-8
x	standard_altimeter_outbound	00:28:56.0	00:00:2.0	0.4	altimetry test 8-8, and reduced duty cycle
y	standard_altimeter_outbound	00:28:58.0	00:00:2.0	0.4	altimetry test 8-8, reduced duty cycle and bandwidth
z	standard_altimeter_outbound	00:29:0.0	00:01:0.0	2.4	Outbound altimetry including wheels transition
lbrace	standard_scatterometer_outbound	00:30:0.0	00:21:0.0	37.8	Outbound scatterometer raster
vbar	standard_radiometer_outbound	00:51:0.0	00:59:0.0	0.9	Radiometry fill during non-radar telemetry mode
rbrace	standard_radiometer_outbound	01:50:0.0	03:30:0.0	12.5	Outbound radiometry scans
Total				799.0	

Table 2: Division summary. Data volumes (Mbits) are estimated from maximum data rate and division duration.

Div	Alt (km)	Slant range (km)	B3 Size (target dia)	B3 Dop. Spread (Hz)
a	0	off target	0.00	off target
b	98152	off target	0.13	off target
c	26042	27269	0.04	298
d	22393	23554	0.03	348
e	15513	15513	0.02	493
f	5188	5188	0.01	1178
g	5178	5178	0.01	1180
h	5168	5168	0.01	1181
i	5158	5158	0.01	1183
j	4610	4726	0.01	1274
k	4551	4665	0.01	1285
l	4492	4603	0.01	1296
m	4434	4541	0.01	1307
n	4375	4479	0.01	1318
o	4317	4417	0.01	1329
p	4258	4355	0.01	1340
q	4200	4294	0.01	1352
r	4143	4232	0.01	1364
s	3980	4061	0.01	1398
t	3980	4060	0.01	1398
u	4709	4822	0.01	1257
v	5309	5309	0.01	1160
w	7929	7929	0.01	867
x	7939	7939	0.01	866
y	7950	7950	0.01	865
z	7961	7961	0.01	864
lbrace	8279	8279	0.01	838
vbar	15119	15539	0.02	505
rbrace	34684	off target	0.05	off target

Table 3: Division geometry summary. Values are computed at the start of each division. B3 Doppler spread is for two-way 3-dB pattern. B3 size is the one-way 3-dB beamwidth

Name	Nominal	Actual	Mismatch	Comments
mode	radiometer	radiometer	no	
start_time (min)	-480.0	-500.0	yes	IEB Trigger time is usually later than this
end_time (min)	-300.0	-301.0	yes	
time_step (s)	2700.0	3600.0	yes	Used by radiometer only modes - saves commands
bem	00100	11111	yes	
baq	don't care	5	no	
csr	6	6	no	6 - Radiometer Only Mode
noise_bit_setting	don't care	4.0	no	
dutycycle	don't care	0.38	no	
prf (Hz)	don't care	1000	no	
tro	don't care	0	no	
number_of_pulses	don't care	8	no	
n_bursts_in_flight	don't care	1	no	
percent_of_BW	don't care	100.0	no	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	0.248	0.248	no	Kbps - actual data rate may be less
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 4: t23 Div a Warmup block

shows a summary of the divisions used in this observation. Table 3 shows a summary of some key geometry values for each division. Subsequent sections will show and discuss the keyword selections made for each division. Each division table shows a set of nominal parameters that are determined by the operating mode (eg., distant scatterometry, SAR low-res inbound). The actual division parameters from the config file are also shown, and any meaningful mismatches are flagged.

3 Warmup and Radiometry

The radar warmup rider begins at 2007-01-13T00:35:43.000 (-08:02:47.8). During the warmup, the IEB will be set to collect 4-second radiometer data on all 5 beams as shown in table 4. Div B covers the inbound radiometry scans with 1-second radiometry.

4 Div's C,D,{: Scatterometry Scans

The T21 outbound scatterometry scan covers a wide latitude range from about 25 N down to the south pole. It is coordinated with the outbound scatterometry scan in T23 which will partially overlap and provde radiometry and scatterometry data in an orthogonal polarization. These two scans together will allow a determination of the equator to pole temperature gradient. Very low incidence angle coverage is also provided to help with modelling of the surface response.

The IEB instructions for the scatterometry scans are generated by RMSS under the control of the set of config parameters shown in table 6. Scatterometer mode operations use a transmit-receive window offset (TRO) of 6 which makes the echo window 6 PRI's longer than the number of pulses transmitted. This is done to increase the valid time

Name	Nominal	Actual	Mismatch	Comments
mode	radiometer	radiometer	no	
start_time (min)	-300.0	-301.0	yes	
end_time (min)	-120.0	-84.0	yes	
time_step (s)	2700.0	3600.0	yes	Used by radiometer only modes
bem	00100	00100	no	
baq	don't care	5	no	
csr	6	6	no	
noise_bit_setting	don't care	4.0	no	
dutycycle	don't care	0.38	no	
prf (Hz)	don't care	1000	no	
tro	don't care	0	no	
number_of_pulses	don't care	8	no	
n_bursts_in_flight	don't care	1	no	
percent_of_BW	don't care	100.0	no	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	0.992	0.992	no	
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 5: t23 Div b standard_radiometer_inbound block

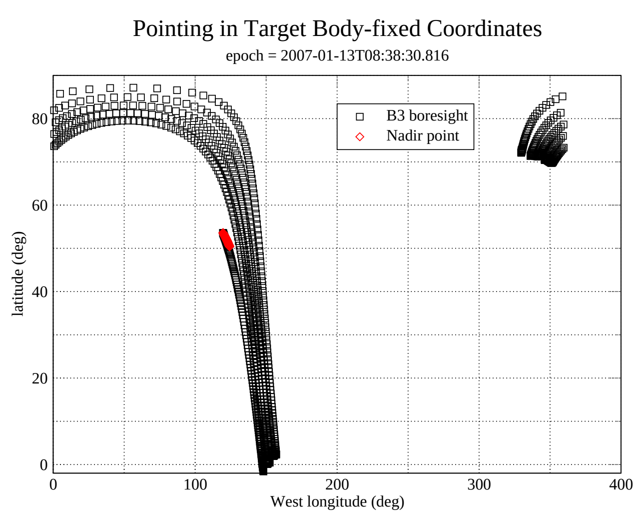

Figure 1: Inbound Scatterometry scan in target body-fixed coordinates

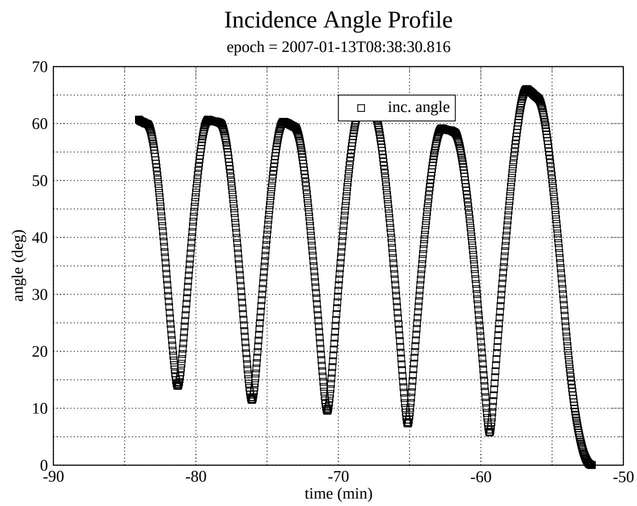

Figure 2: Inbound Incidence angle variation during scatterometry scan

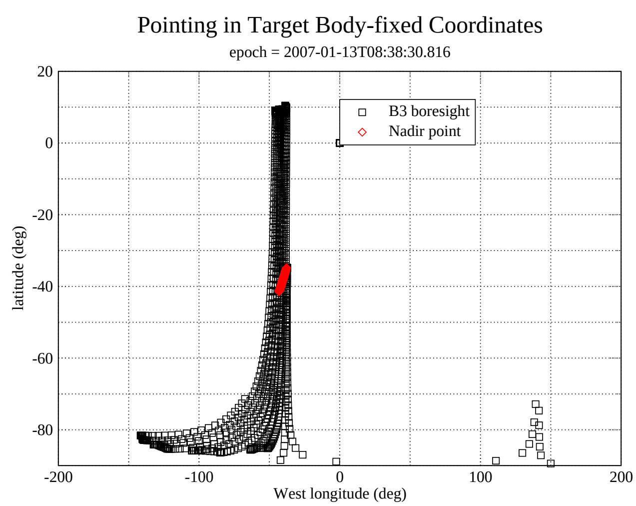

Figure 3: Outbound Scatterometry scan in target body-fixed coordinates

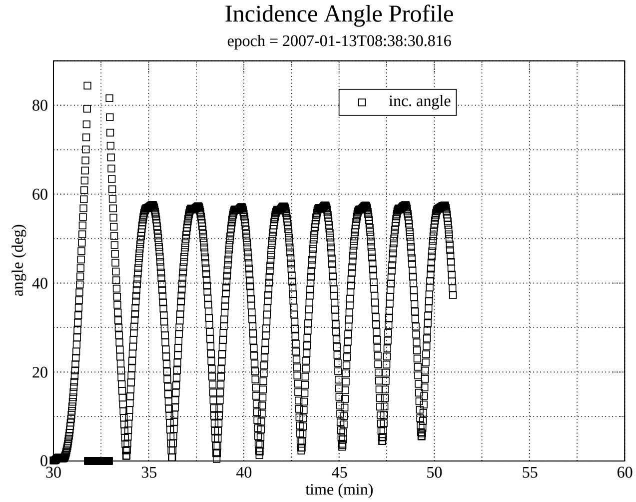

Figure 4: Outbound Incidence angle variation during scatterometry scan

Name	Nominal	c	d	lbrace	Mismatch	Comments
mode	scatterometer	scatterometer	scatterometer	scatterometer	no	
start_time (min)	varies	-84.0	-73.0	30.0	no	
end_time (min)	varies	-73.0	-52.2	51.0	no	
time_step (s)	don't care	12.0	12.0	12.0	no	Set by valid time calculation
bem	00100	00100	00100	00100	no	
baq	5	5	5	5	no	5 - 8 bits straight
csr	0	0	0	0	no	0 - No auto-gain, fixed attenuator set to avoid clipping
noise_bit_setting	4.0	4.0	3.0	3.0	yes	9 dB attenuator
dutycycle	0.70	0.70	0.70	0.70	no	
prf (Hz)	1200	1200	1200	1200	no	
tro	6	6	6	6	no	
number_of_pulses	8	8	8	8	no	
n_bursts_in_flight	1	1	1	1	no	
percent_of_BW	100.0	100.0	100.0	100.0	no	
auto_rad	on	on	on	on	no	
rip (ms)	34.0	34.0	34.0	34.0	no	
max_data_rate	30.000	30.000	30.000	30.000	no	leaving as much data for SAR as possible
interleave_flag	off	off	off	off	no	
interleave_duration (min)	don't care	10.0	10.0	10.0	no	

Table 6: t23 Div cdlbrace standard_scatterometer_inbound block

Name	Nominal	e	v	Mismatch	Comments
mode	altimeter	altimeter	altimeter	no	
start_time (min)	-30.0	-52.2	20.5	yes	
end_time (min)	-19.0	-20.1	28.9	yes	
time_step (s)	don't care	10.0	10.0	no	Set by valid time calculation
bem	00100	00100	00100	no	
baq	7	7	7	no	7 - 8 to 4
csr	8	8	8	no	8 - auto gain
noise_bit_setting	2.3	2.3	2.3	no	
dutycycle	0.73	0.50	0.50	yes	
prf (Hz)	5000	5000	5000	no	
tro	don't care	-6	-6	no	auto set to -6 except interleaved bursts where +6 is used
number_of_pulses	21	21	21	no	
n_bursts_in_flight	1	1	1	no	
percent_of_BW	100.0	100.0	100.0	no	
auto_rad	on	on	on	no	
rip (ms)	34.0	34.0	34.0	no	
max_data_rate	30.000	40.000	40.000	yes	
interleave_flag	on	on	on	no	
interleave_duration (min)	varies	9.0	6.5	no	

Table 7: t23 Div ev standard_altimeter_inbound block

for an instruction by letting the pulse echos walk through the longer echo window before the range-gate needs to be updated. This is particularly important during Titan scatterometry raster scans where the number of instructions needed to track the varying range can exceed the number available if a smaller TRO value is used. The positive TRO value also guarantees noise-only data in each burst which eliminates the need to insert special noise-only bursts. The PRF of 1.2 KHz is high enough to cover the doppler spread within beam 3, so doppler sharpening could be performed.

During Ta, the scatterometry scans suffered from clipping during the center of the scan lines. The clipping occurred because RMSS placed all of the instruction boundaries near the outer edges of the scan where they were most needed to track the rapidly varying range. Thus, the auto-gain algorithm did not have an opportunity to see the higher signal levels near the center of the scan lines where the incidence angle dropped close to nadir pointing. To prevent this problem from recurring, auto-gain will not be used for scatteromtry raster scans. Instead, a fixed attenuator value will be used to keep the signal on-scale over the whole raster scan. Based on experience with T3, a 15 dB attenuator setting will be used for scan lines that go below 10 degrees incidence. For T23, the closer range half of the inbound and all of the outbound scatterometer scan lines go below 10 degrees incidence and a 15 dB attenuator is used here. The first few scan lines of the inbound scan are above 10 degrees incidence so the 9 dB attenuator setting is used.

5 Div's E-H,V-Z: Altimetry

The spacecraft performs a transition from momentum wheel to thruster attitude control at higher ranges just outside of the altimeter segments. During this time, the -Z axis (high gain antenna axis) is pointed at nadir, so we collect data in altimetry mode. The altitude here is higher than the nominal altimetry, so performance will suffer, and pointing performance is not guaranteed. Div's F-H and W-Z perform some diagnostic checks to make sure there are no issues with the altimetry data. These are repeats of the test performed in T21. The parameters used by the main altimeter segments are shown in table 7. Note that the pulse duty cycle has been reduced from 70% to 50% to provide better echo separation.

Name	Nominal	Actual	Mismatch	Comments
mode	sarh	sarh	no	
start_time (min)	-6.0	-16.0	yes	
end_time (min)	6.0	16.0	yes	
time_step (s)	don't care	10.0	no	Set by valid time calculation unless negative, then time_step is used instead
bem	11111	11111	no	
baq	0	0	no	0 - 8 to 2
csr	8	8	no	8 - auto gain
noise_bit_setting	3.0	3.0	no	
dutycycle	0.70	0.70	no	
prf (Hz)	don't care	0	no	RMSS follows profile
tro	don't care	0	no	
number_of_pulses	don't care	0	no	RMSS fills round trip time
n_bursts_in_flight	1	1	no	
percent_of_BW	100.0	98.0	yes	
auto_rad	off	off	no	Set off for SAR modes to allow minimum burst time
rip (ms)	34.0	34.0	no	Calculated from radiometer calibration for prior observations
max_data_rate	255.000	238.000	yes	8 to 2 reduces max data rate possible
interleave_flag	on	off	yes	
interleave_duration (min)	varies	10.0	no	

Table 8: t23 Div s standard_sar_hi block

6 Div's I-U: SAR Imaging

The SAR swath is pushbroomed at both ends. Div's I-R ping-pong back and forth every 12 seconds between Hi-SAR and Low-SAR with overlapping pixels. This provides a small increase in image quality since the two modes provide rectangular pixels with the short side in different directions. Div S covers the 32 minutes centered on closest approach. Hi-SAR is used throughout to obtain the best resolution possible. At +16 minutes, range and azimuth resolution and SNR favor Low-SAR and the instrument switches to this mode in div T. Targetting of the outbound pushbroom profile ends at +18.5 minutes. SAR-Hi mode is used during the backsweep to nadir in div U. This extra coverage may provide some stereo opportunities. Table 8 shows the standard Hi-SAR divisions, table 9 shows two representative Low/Hi-SAR ping pong divisions, and table 10 shows the B3 only Hi-SAR divisions at the ends. The left look option is selected here to produce a swath that crosses just north of the Ta swath in the Ganesha area.

Name	Nominal	j	k	Mismatch	Comments
mode	sarl	sarl	sarh	yes	
start_time (min)	-19.0	-18.2	-18.0	yes	
end_time (min)	-6.0	-18.0	-17.8	yes	
time_step (s)	don't care	6.0	6.0	no	Set by valid time calculation
bem	11111	11111	11111	no	
baq	0	0	0	no	0 - 8 to 2
csr	8	0	0	yes	8 - auto gain
noise_bit_setting	3.0	2.9	3.4	yes	
dutycycle	0.70	0.70	0.70	no	
prf (Hz)	don't care	0	0	no	RMSS follows profile
tro	don't care	0	0	no	
number_of_pulses	don't care	0	0	no	RMSS fills round trip time
n_bursts_in_flight	1	1	1	no	
percent_of_BW	100.0	100.0	100.0	no	
auto_rad	on	off	off	yes	
rip (ms)	34.0	34.0	34.0	no	
max_data_rate	255.000	215.000	238.000	yes	8 to 2 reduces max data rate possible
interleave_flag	on	off	off	yes	
interleave_duration (min)	varies	10.0	10.0	no	

Table 9: t23 Div jk standard_sar_low_inbound block

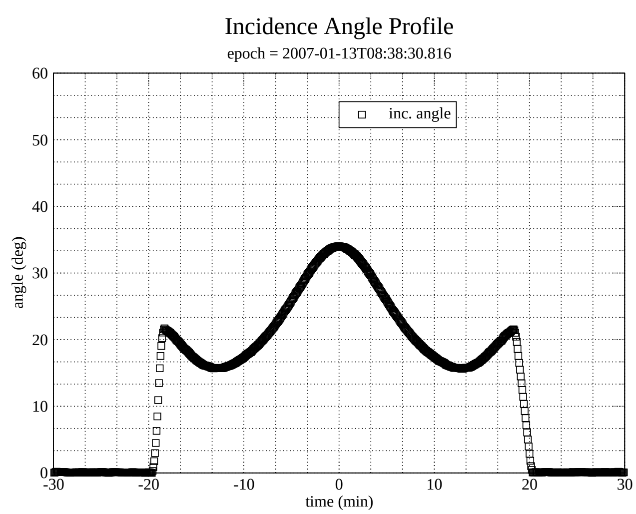

Figure 5: B3 boresight incidence angle during the time around c/a.

Name	Nominal	i	u	Mismatch	Comments
mode	sarh	sarh	sarh	no	
start_time (min)	-6.0	-20.0	18.5	yes	
end_time (min)	6.0	-18.2	20.5	yes	
time_step (s)	don't care	6.0	6.0	no	Set by valid time calculation unless negative, then time_step is used instead
bem	11111	00100	00100	yes	
baq	0	0	0	no	0 - 8 to 2
csr	8	0	8	yes	8 - auto gain
noise_bit_setting	3.0	3.4	3.0	yes	
dutycycle	0.70	0.70	0.70	no	
prf (Hz)	don't care	0	0	no	RMSS follows profile
tro	don't care	0	0	no	
number_of_pulses	don't care	0	0	no	RMSS fills round trip time
n_bursts_in_flight	1	1	1	no	
percent_of_BW	100.0	100.0	100.0	no	
auto_rad	off	off	off	no	Set off for SAR modes to allow minimum burst time
rip (ms)	34.0	34.0	34.0	no	Calculated from radiometer calibration for prior observations
max_data_rate	255.000	238.000	238.000	yes	8 to 2 reduces max data rate possible
interleave_flag	on	off	off	yes	
interleave_duration (min)	varies	10.0	12.0	no	

Table 10: t23 Div iu standard_sar_hi block

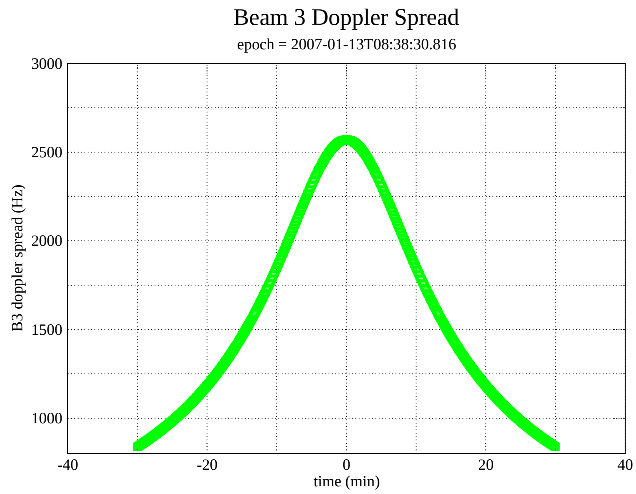

Figure 6: Nadir pointed B3 doppler spread during the time around c/a. Doppler spread is measured within the two-way 3 dB beam pattern.

6.1 PRF and Incidence Angle Profiles

The PRF profile and incidence angle profile (Fig. 5) are optimized for maximum usuable imaging coverage. The Ta profiles were produced for a 950 km flyby which is the most common SAR flyby altitude. The T3 profiles were optimized for a 1500 km flyby. The T23 flyby will be at 1000 km altitude, and the lower altitude profile used at Ta will be used again here. The optimized profile maximizes usable cross-track width while avoiding gaps in the imaging swath. Unlike some previous SAR imaging passes, this pass will not include any PRF hopping which has not proven necessary.

6.2 SAR Resolution Performance

For all of the SAR divisions the effective resolution can be calculated from the following equations,

$$\delta R_g = \frac{c}{2B_r \sin\theta_i}, \tag{1}$$

$$\delta x = \frac{\lambda R}{2\tau_{rw} v \sin\theta_v}, \tag{2}$$

where δR_g is the projected range resolution on the surface, c is the speed of light, B_r is the transmitted chirp bandwidth, θ_i is the incidence angle, δx is the azimuth resolution on the surface, λ is the transmitted wavelength, R is the slant range, τ_{rw} is the length of the receive window, v is the magnitude of the spacecraft velocity relative to the target body, and θ_v is the angle between the velocity vector and the look direction. Figure 7 shows the results from these equations for the Ta flyby using the parameters from the IEB as generated by RMSS. The calculations are performed for the boresight of beam 3 which is the center of the swath.

Projected range increases with decreasing incidence angle, so the range resolution varies across the swath with better resolution at the outer edge. The SAR pointing profile decreases the incidence angle as time progresses and altitude increases, so there is progressive deterioration of range resolution away from closest approach. The projected range resolution rapidly deteriorates as the incidence angle decreases toward zero at the very beginning and end of the swath.

Azimuth resolution is a function of the synthetic aperture size which is determined by the length of the receive window in each burst (assuming the receive window is always filled with echos). Azimuth resolution deteriorates less quickly because the number of pulses and the length of the receive window are increased as altitude increases which mitigates the increasing doppler bandwidth of the beam patterns. The receive window length increases to fill the round trip time until the science data buffer is filled. At this point it is no longer possible to extend the receive window, and azimuth resolution starts to deteriorate more rapidly.

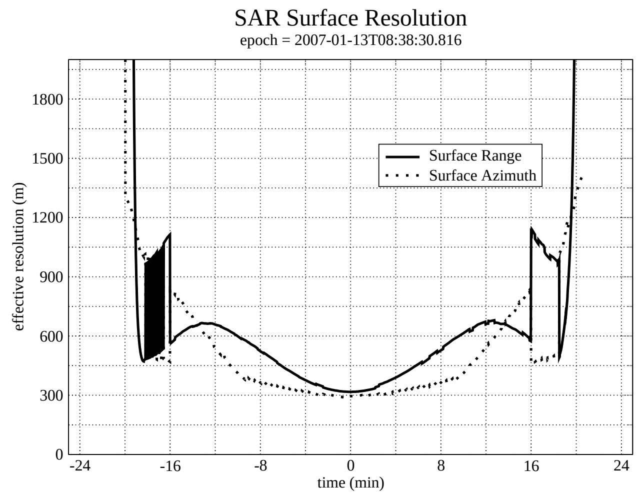

Figure 7: SAR projected range and azimuth resolution. These values are computed from the IEB parameters and are not related to the pixel size in the BIDR file. The pixel size was selected to be always smaller than the real resolution.

7 Radiometry: Div's B,||,}

The inbound and outbound radiometry scans both have twin scans with two different polarizations. Their parameters are shown in table 11 Div || puts the instrument in radiometer mode while other instruments collect data. These radiometer data will not be downlinked.

8 Revision History

1. Nov 22, 2006: Initial release

Name	Nominal	b	rbrace	Mismatch	Comments
mode	radiometer	radiometer	radiometer	no	
start_time (min)	-300.0	-301.0	110.0	yes	
end_time (min)	-120.0	-84.0	320.0	yes	
time_step (s)	2700.0	3600.0	2700.0	yes	Used by radiometer only modes
bem	00100	00100	00100	no	
baq	don't care	5	5	no	
csr	6	6	6	no	
noise_bit_setting	don't care	4.0	4.0	no	
dutycycle	don't care	0.38	0.38	no	
prf (Hz)	don't care	1000	1000	no	
tro	don't care	0	0	no	
number_of_pulses	don't care	8	8	no	
n_bursts_in_flight	don't care	1	1	no	
percent_of_BW	don't care	100.0	100.0	no	
auto_rad	on	on	on	no	
rip (ms)	34.0	34.0	34.0	no	
max_data_rate	0.992	0.992	0.992	no	
interleave_flag	off	off	off	no	
interleave_duration (min)	don't care	10.0	10.0	no	

Table 11: t23 Div brbrace standard_radiometer_inbound block

9 Acronym List

ALT	Altimeter - one of the radar operating modes
BAQ	Block Adaptive Quantizer
CIMS	Cassini Information Management System - a database of observations
Ckernel	NAIF kernel file containing attitude data
DLAP	Desired Look Angle Profile - spacecraft pointing profile designed for optimal SAR performance
ESS	Energy Storage System - capacitor bank used by RADAR to store transmit energy
IEB	Instrument Execution Block - instructions for the instrument
ISS	Imaging Science Subsystem
IVD	Inertial Vector Description - attitude vector data
IVP	Inertial Vector Propagator - spacecraft software, part of attitude control system
INMS	Inertial Neutral Mass Spectrometer - one of the instruments
NAIF	Navigation and Ancillary Information Facility
ORS	Optical Remote Sensing instruments
PDT	Pointing Design Tool
PRI	Pulse Repetition Interval
PRF	Pulse Repetition Frequency
RMSS	Radar Mapping Sequencing Software - produces radar IEB's
SAR	Synthetic Aperture Radar - radar imaging mode
SNR	Signal to Noise Ratio
SOP	Science Operations Plan - detailed sequence design
SOPUD	Science Operations Plan Update - phase of sequencing when SOP is updated prior to actual sequencing
SSG	SubSequence Generation - spacecraft/instrument commands are produced
SPICE	Spacecraft, Instrument, C-kernel handling software - supplied by NAIF to use NAIF kernel files.
TRO	Transmit Receive Offset - round trip delay time in units of PRI